Temporal and geographical changes in reporting rates and case fatality for measles in Denmark 1870-1960

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Temporal and geographical changes of reporting rates and case fatality for Measles in Denmark 1870 - 1960

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Introduction

Pre-vaccination measles epidemiology is expected to depend on population density and contact patterns. The measles reporting rate is determined by a mixture of biological aspects (such as variation in the clinical picture due to nutritional status) and behavioral aspects like propensity to seek medical care.

We expect that measles transmission increases with birth cohort size and population density and therefore that:

1. age at infection is higher in low population areas
2. case-fatality ratio (CFR) is higher in low density areas, since complications and death increase with age at infection
3. infection in infants is independent of population density
4. reporting rate varies with degree of urbanisation

Methods

Settings During 1870 to 1960, Danish health statistics distinguishes between 3 ”settings”, that is, levels of urbanisation: Copenhagen (Cph), Urban (Province towns) and Rural areas. Population density changed over time as seen in table.

Reporting rate Historical time series of measles morbidity are based on case notifications reported by physicians. Assuming that all individuals are infected by measles at some point during life, we determined the reporting rate as the 40-year moving average of measles cases divided by number of birth in that period.

Data We collected the following data[1,2]:

- Notifiable clinical cases of measles 1870-1960 -- by year, age and setting
- Births and infant deaths -- by year and setting
- Measles deaths -- by year and setting (rural data only after 1921)

*Table: Population density 1870-1960, by setting: Copenhagen (Cph), urban, and rural area including villages and small towns. *) Major change in districts in 1920.*

	Population density in thousands per km²				
	1870	**1901**	**1921*)**	**1940**	**1960**
Cph	13.7	28.6	6.9	8.6	8.9
Urban	0.43	1.02	0.71	1.03	1.43
Rural	0.047	0.04	0.044	0.05	0.06

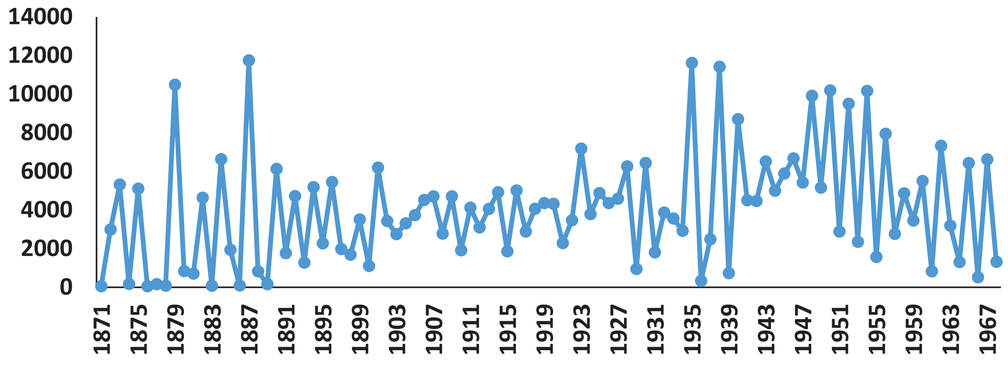

Figure 1: Annual measles notifications in Copenhagen, 1871-1968. Transmission dynamics are in agreement with observations made in London and other populations.[3-5]

Results

- Total incidence of measles follows similar patterns as observed for other populations (data not shown here).[3-5]
- Age at infection increases as population density decreases (from Cph to rural).
- Infection among infants is independent of population density but declines over the period 1870-1960.
- Reporting rates grow for both urban and rural populations.
- The CFR declines about 200-fold before the introduction of vaccination and antibiotics. The CFR is highest in Cph which is also most densely populated.

Conclusions

- Historical long time series allow the robust estimation of reporting rates and case fatality ratios.
- Historically, measles reporting rates are lower in rural than in urban populations, in modern times, reporting rates may not stable over long periods.
- For the rural population, increased access to physicians and mobility may have impacted the reporting rate disproportionately.
- Unexpectedly, the CFR is highest in Copenhagen rather than urban settings. This may be due to higher intensity of exposure, in agreement with Aaby et al.[6]
- Declines in CFR 50 years before modern medical interventions cannot be explained by an increasing reporting rate.

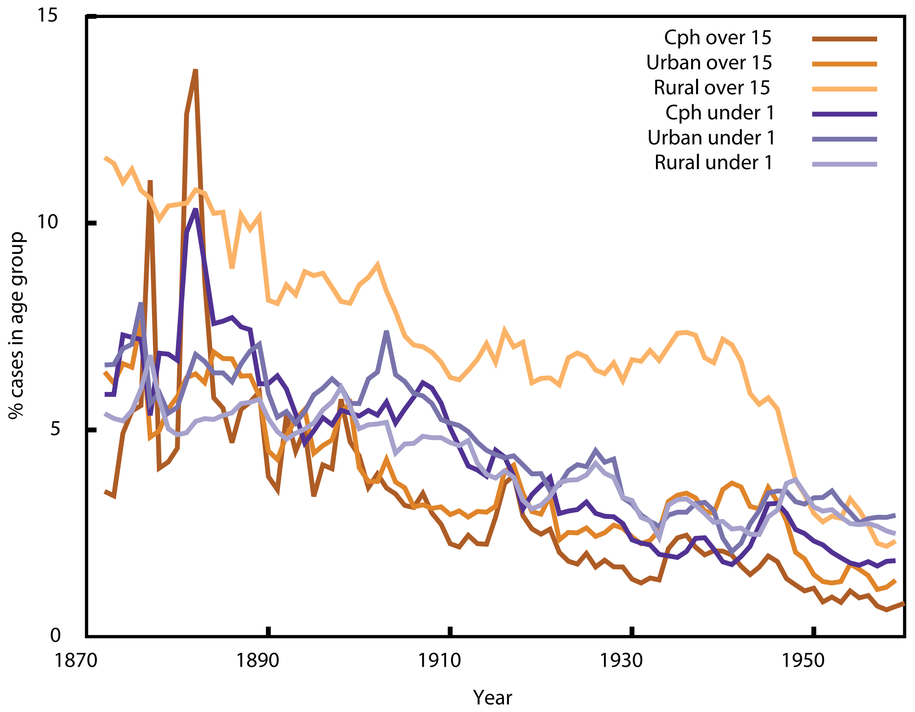

Figure 1: 100 years annual measles case notifications in Denmark by degree of urbanisation - shown as the proportion under 1 and over 15 years-of-age with 3-year smoothing.
There is a higher percentage of measles cases among adults in rural areas and this proportion, similar to other areas, declines over time. The decline is consistent with degree of urbanisation and similar for <1 and >15.

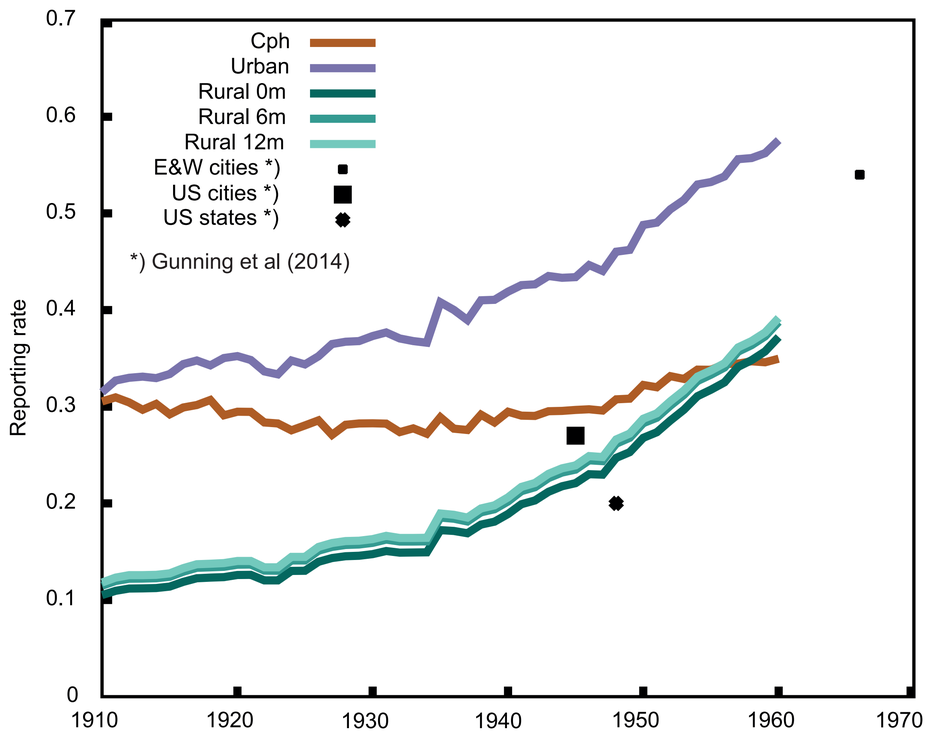

Figure 2: Reporting rate in Denmark by urbanisation level in a 40-year moving average window (Copenhagen, urban and rural). Rural rates are adjusting for infant mortality (0 months, 0-6 months, and 0-12 months) - this did not have a substantial impact.Three estimates from Gunning et al [7] are added for reference (E&W stands for cities in England and Wales).
Reporting rates increased over time and this rate of increase depended on degree of urbanisation, but were less pronounced for Copenhagen.

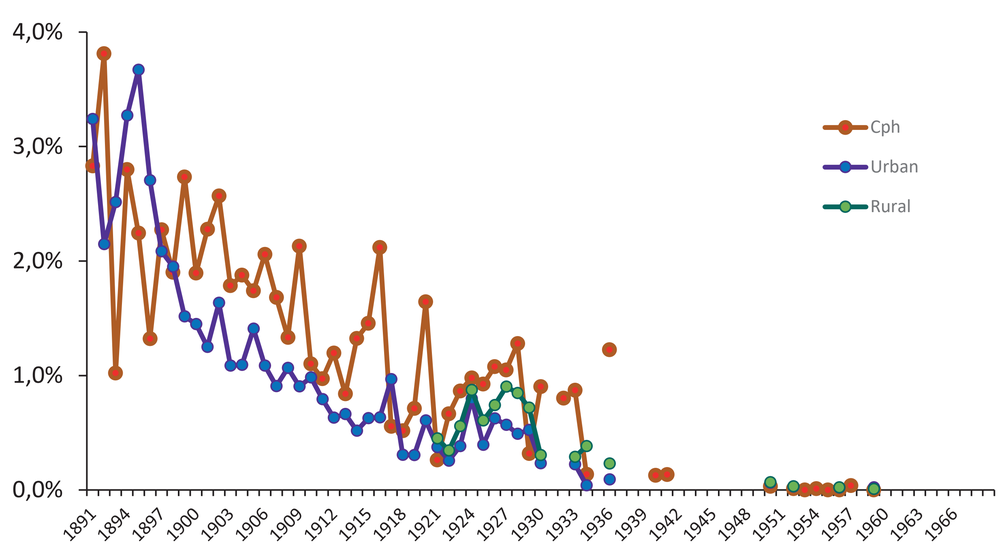

Figure 3: Case fatality rate (CFR) among notitiable measles cases from 1891-1960.
The CFR drops 200-fold in Copenhagen and urban settings over a period of 70 years, and was consistently higher in Copenhagen. Rural patterns, available after 1920, were similar.

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